Do Mobile Learning Devices Enhance Learning In Higher Education Anatomy Classrooms?

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Abstract
Recently there has been an increased volume of research and practice of mobile Learning (mLearning) and in particular of the tablet device. The question of how, when and where to best incorporate the tablet device into the learning environment in Higher Education remains largely unanswered. The article presents the findings of an empirical study that examined the effect of integrating mobile learning tablet devices into first year University anatomy seminars in a group of Sport and Exercise students. Data on student achievement, attendance and feedback was collected over two academic years and two cohorts, comparing seminar groups taught with tablet devices (iPads) integrated with traditionally taught anatomy seminars. The results indicate that the iPads had a positive effect on attendance,

achievement and progression, highlighting the need for a framework as to how the tablet should be incorporated to maximise the learner experience. This article offers insight into the implications of successful mLearning using tablets and into how we, as educators might use the tablet device as a tool to provide a more engaging, successful learning environment which positively impacts on student achievement and independent truly mobile learning outside of the classroom.

Keywords: Tablet, mobile Learning, iPad, Higher Education, anatomy, engagement

Anatomy Education in Higher Education (HE)

Anatomy is an integral part of any Sport and Exercise programme of study as well as core to medical and veterinary degrees. Within a Sports Science/Rehabilitation programme students are required to construct a comprehensive and sophisticated understanding of basic anatomy, and then apply that information to the athlete for performance, health or rehabilitation (Ward and Walker, 2008). Anatomy requires students to learn a large volume of Latin terminology and functions including muscle names, origins, insertions, joint, connective tissue and cellular gross and micro anatomy. Students traditionally use a rote or surface learning approach and have suggested anatomy is 'boring, hard, dull' in previous literature (Noguera, 2013; Hopkins, 2011). Miller et al., (2002) discusses the perception of anatomy as a subject, primarily for health practitioners but agrees that the common misconception is the reliance on memorising words and facts without the subsequent gross understanding and fundamental concepts.

For medical students, a high workload, volume of new information, and the pressures of a vocational course often cause students to prepare for exams using ineffective study methods for long-term recall potential which could limit understanding (Schoenfeld, 1987; Radcliffe and Lester, 2003). Moreover, some learners continue using the first study method they adopt, no matter how detrimental such practices eventually become to their success and long-term recall (Newble and Gordon, 1985). The integration of study skills into most degree programmes has hopefully positively influenced this, encouraging more student self-reflection (Koole et al., 2012). There is, however, still evidence of single method and reliance on copying, memorising and visualisation (Ward and Walker, 2008; Miller, 2002).

Mobile Learning in Higher Education

Traxler, (2013) defines mobile learning (mLearning) as learning using mobile technologies such as mobile phones, smartphones, e-readers and tablets, and argues that these devices offer 'unparalleled access to communication and information'. The suggestion that the increased affordability and functionality of mobile technology compared to technologies previously used in education means they can support learning in new ways within the classroom and at home. Much of the research into tablet education has been done in school-aged learners but the integration into HE has been less uniform, mirroring the inconsistent use by HE academics (Nguyen et al., 2014).

mLearning is purported to educate the learner to identify how and where they learn best hence increasing the autonomy of the learner. Personalisation of learning is highlighted as an important factor in engagement and mobile technologies claim to allow the student to contextualise and take ownership of their own learning (Clarke and Svanaes, 2014). They also bridge the gap between formal and informal learning environments and transcend environmental limitations.

Smartphone and tablet devices have also been highlighted as being influential in improving the feedback process between staff and students allowing greater understanding of the wider learning process. Mobile applications such as Skype, audio playback, FaceTime and other social media and communication portals have been identified in the feedback process and therefore in the students' increased ability to achieve their potential (Cochrane, 2014). Furthermore, mLearning allows students to access education in a flexible and seamless manner, at any time and any place, which substantially increases their access to learning. Moreover, m-learning offers the potential for significant innovation in the delivery of even more flexible education by allowing for the personalisation and customisation of the student learning experience (Johnson et al., 2011).

Mobile devices and apps are critical in the potential of provision and adoption of m-learning (Mang & Wardley, 2012). Not surprisingly, there have been many attempts to explore how iPads or other tablet devices could be used in the education sector around the world (Lindsey (2011)); Brand, et al., (2011)) but mainly in school-age students.

The Role of the Mobile Learning Device in Teaching

The tablet has been found to help engagement and potentially enhance students' learning experience (Brand et al, 2011; Diemer, Fernandez & Streepey, 2012; Fontelo, Faustorilla, Gavino & Marcelo, 2012; Perez et al, 2011). The concept of engagement has been contested as to how it can be measured and is therefore not a reliable outcome and although students perceived them to be positive to learning they had no measurable effect on achievement of learning outcomes in final module results (Perez et al, 2011). Other research of various designs agrees that tablets generally receive a positive reaction from students, however cannot directly be linked to an impact on their grades. Positive areas identified from the research are deeper learning material resources from YouTube, Google Scholar and the Virtual Learning Environment (Blackboard) (Alyahya & Gall, 2012; Fontelo et al, 2012). In addition, students often used tablets for information seeking (Alyahya & Gall, 2012; Geist, 2011; Wakefield & Smith, 2012) notetaking and presentations in class. Photos and videos (Alyahya &Gall, 2012; Hahn & Bussell, 2012; Mang &Wardley, 2012; Sloan, 2012) were seen to be a positive and generally seen to increase efficiency in group work (Geist, 2011). A consistent finding, however, across several studies was that the tablet could potentially be a distraction because of non-educative usage (Kinash et al, 2012; Rossing et al, 2012; Wakefield & Smith, 2012) agreeing with many academics. The scepticism of many academics of the research (Hargis et al, 2013; Link et al, 2012; Rossing et al, 2012) was most often because of its role as a potential distraction, however, this may highlight behavioural management and pedagogical limitations rather than a direct association with the use of the tablet device. Link et al (2012) reported additional concerns including regarding percentage of tablet ownership and the need for a clear role and space of the mobile learning device in the classroom to avoid its distraction. The proportion of academics utilising tablet devices in classes ranges from 20% (Yeung & Chung, 2011) to 37% (Lindsey, 2011) but many more reported using it for administrative tasks and meetings. Vu et al. (2014) investigated student-teacher use of the tablet as a tool in secondary aged classes finding that interactive time increased with one tablet for each group as opposed to one tablet for each student, leading to improved group work. The least positive teacher comments from the qualitative data was from those who used the tablet as a teacher tool, one per class and therefore the level of active learning increase was not apparent. There are, of course financial implications for educational establishments providing tablet devices and 'Bring Your Own Device' (BYOD) raises the ethical issue of inclusion and is dependent on student access. Many researchers have discussed the inclusion concerns regarding mLearning devices but where alternatives are also offered using more traditional methods it is generally agreed that it is no more of concern than the traditional reading list cost (Cochrane et al., 2014). Many educational apps are free and web resources remain integrated within Virtual Learning environments (VLEs).

In a review by Nguyen et al., (2014) they suggest that not only do the long term effects of the iPad and tablets need to be investigated further but also the pedagogical transformation they can have on teaching methods, curriculum and classroom dynamics. The aim of the current study is to investigate the impact of integrating group mobile learning tablet devices in first year Higher Education Anatomy seminars on achievement and attendance.

Methods

No data was collected that was not part of the normal academic procedure, and so deemed ethical by the University Department sub-committee and an action research methodology was used for practitioner inquiry. The study was part of a wider project where this study was based on grounded theory as the initial phase of a long term action research project. 6 iPads were bought using a successful Teaching and Learning bid by the department which were all enabled with Wi-Fi and the relevant apps needed for the module uploaded prior to the module run. This meant that there was no cost to the student and no access issues for the study.

There were 12 whole group lectures, 24 seminars and four assessments throughout the course which is part of a 24 week core level 4 module of an Undergraduate Sport and Exercise (SES) degree programme. The lectures were taught during semester one by the module leader. In the 2012-13 academic year the level 4 module was split into eight seminar groups of 20 students as per the normal timetabling for the module. Six seminar groups were taught with iPad activities integrated into the seminars, two used traditional teaching methods with no classroom orientated technology; this was repeated in 2013-14. No students were knowingly disadvantaged and all students followed the same content and online learning activities, the only difference being the addition of the iPads. The iPads were available in all seminars but were utilised as part of group tasks depending on the session. This included Socrative™ teacher-paced plenary quizzes, Real Bodywork™ Muscles and bone and skeletal 3D apps as well as the video features and apps such as Flipagram™ and Magisto™ alongside more traditional tools such as Youtube™ and Safari/internet. In each session, a lesson plan was used as is normal which was the same across all eight seminars; the six iPad groups had the tablet specific tasks integrated at specific points. Tasks were designed to encourage group learning and opportunities for independent mLearning. For example, students were encouraged to use the Real bodywork apps outside of the seminars and videos made in class were published on the VLE via Youtube to allow student owned revision aids to access autonomously.

Anatomy Assessments

There are four points of assessment throughout the course, A1, A2, A3, and A4 as shown in Table 1. The module aims to give students the fundamental anatomical knowledge to apply to the Sports Science arena and is assessed on Moodle using a time limited multiple choice quiz (MCQ) (A1, A2, A3) that the students completed in a controlled examination environment. A4 is a viva voce lasting 15 minutes where students were asked to utilise the skeleton and coach exercises to show applied knowledge and understanding on the topic. Assessments were tested for internal consistency using an expert review panel and reliability using Alpha-Cronbach's coefficient. The coefficient was calculated at 0.76, greater than the 0.7 required for reliability and therefore deemed comparable.

Table 1. Anatomy assessments

Assessment	**A1**	**A2**	**A3**	**A4**
timing	8	14	20	24
type	Online MCQ	Online MCQ	Online MCQ	Viva voce
Content	Anatomical microstructure	Applied gross anatomy (lower limb)	Applied gross anatomy (upper limb)	Applied gross anatomy (trunk and nervous system)

3.2 Participants

In 2012-13 the total number of students completing the module was (N=128); the iPad group (N= 101) and the Traditional group (N=27) and in 2013-14 the total number of students (N=123) split into traditional (N= 33) and iPad (N=90) students for seminar teaching. Therefore whole group data (N=251) consisted of the iPad group (N=191) and traditional group (N=60). Students who did not complete two or more assessments were excluded from the data analysis as non-completers. All students had access to online activities and suggested independent mLearning activities from the lead lecturer. Learning Style was suggested from the Learning Style Preference questionnaire (Reid, 1992) measured as part of the professional skills module and was analysed because of the group teaching methods employed within the study. This was to ensure that the students were of a varied learning styles and no differences between the years or groups existed that could bias the potential impact of the iPads. Measures of Achievement and Engagement were recorded; Attendance, Achievement, completion and qualitative online feedback. There was a discussion board and feedback questionnaire which allowed the students to provide feedback throughout the year.

No significant differences between the groups for Learning Style or Group vs individual Learners ($p>0.05$); 34.9% Individual Learners; 65.1% Group Learners were identified. The numerical data was tested for normality using a Kolmogorov–Smirnov test and was assumed to be parametric ($p>0.05$). The data was analysed using independent t- tests and within-subject ANOVAs using a 95% confidence level.

The online qualitative feedback was voluntary with only 3 open questions; asking for positives, areas for improvement and any areas where they felt they needed additional help. Feedback was analysed with respect to themes being identified from the responses. The positive themes identified were; fun, iPads, models, quizzes. Only 2 areas for improvement were stated out of the 96 responses and therefore deemed too few for analysis.

Results

Progression

The mean completion rate for the module was 94.6%, the iPad group 96.3% and the traditional group, 93.6% after the resubmission board. The completion rate was 89.4% for the iPad group and 87.1% for the traditional group prior to the resubmission board. The iPad group had 6.1% non -submission for one or more assessment, the traditional group 9.6%.

Teaching Method

The mean whole group data was analysed for iPad (N= 191) and traditional groups (N=60) where the mean values for final grade revealed a significantly greater grade ($p<0.05$) for the iPad groups (57.9 ± 13.0 %) compared to those taught using traditional methods (52.2 ± 12.5%). A1, A4 and the A1-A4 difference were also highly significantly greater for the iPad group ($p<0.01$). Using an independent t-test all of the values were shown to be significantly greater ($p<0.05$) at the 95% confidence level (Figure 1). There was no significant difference between the two years and therefore only whole group data is presented.

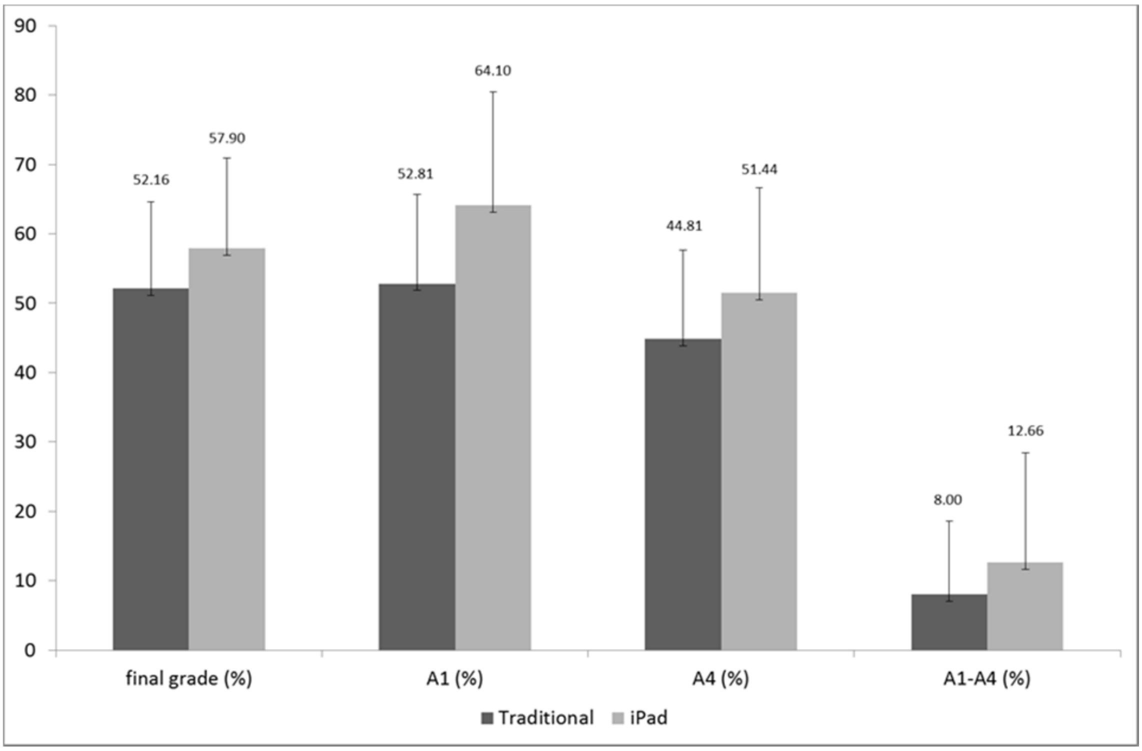

Figure 1. SES achievement scores for iPad and traditionally taught groups

A1 was used as the baseline reading as the first assessment based on anatomical theory; a within subject ANOVA followed by a Tukey post hoc test was used to compare achievement between A1, A2, A3, A4 assessment points to see how the two groups (tablet and traditional) performed at each. In the iPad group there was a highly significant improvement at all assessment points compared to their baseline A1 score ($p<0.01$). In the traditional group there was a significant improvement between A1 and A4 ($p<0.05$), but at no other assessment points. The mean improvements between A1 and A2 were

4.8± 24.0% in the traditional group and 7.7± 20.1% in the iPad group. Between A1 and A4 the improvement was 9.4±21.4% in the traditional group and 13.8±19.8% in the iPad group.

Attendance

Attendance data was analysed for iPad (88.6 ± 8.9 %) and Traditional groups (77.4 ± 9.8 %) across both years revealing a significantly greater attendance in the iPad taught groups compared to the traditional groups ($p<0.01$).

Discussion

The purpose of this investigation was to identify whether using tablets in first year Anatomy seminars was beneficial to student achievement, attendance and progression. The initial hypothesis was that the groups being taught with tablet activities and access integrated into seminars would have better achievement scores than those who did not. This was accepted for where those students using tablets in classes had consistently greater scores across all of the assessment points in the year. The students were randomly assigned to their groups as per normal timetabling and no differences in standard entry point criteria or learning style was observed. A1 was performed in week eight of semester one and therefore no true baseline data for the two groups was measured so it can only be assumed that the level of knowledge in week one would have been consistent between the two groups.

Weekly strategies employed in the tablet integrated seminars included using Real Bodywork Muscles and Skeletal 3D apps which are highly visual anatomical learning tools with quiz and labelling games functions. Quizzes were used at the beginning of each session to stimulate knowledge recall from their previous learning as well as after a task to further assist in learning the new topic. Quizzes have been suggested to help motivate students to complete autonomous learning tasks, increase participation in class discussion, and improve performance on exams for material covered both on the quizzes and in class (Hillman, 2012; Brothen & Warmback, 2004; Johnson & Kiviniemi, 2009). Although we cannot specify how the tablet increased achievement, the use of quizzes as a group learning tool could potentially have an effect. The traditional and iPad groups both had access to all online learning material and weekly quizzes on the VLE and again, if our students behaved like those in Johnson and Kiviniemi, (2009) it could be suggested that use of mLearning quizzes in class could increase interaction with the VLE quizzes independently therefore positively impacting on out of class engagement. Measures of interaction with the VLE (by number of clicks, visits and external links accessed) and attempting to measure the use of the sources introduced in seminars accessed via mLearning on student owned tablets or smartphones independently are areas requiring further investigation to look at the effect on true mLearning.

However, the increased achievement seen in our students who were taught using tablets disagrees with Perez et al., (2011) who found no direct link to achievement even though they were seen to be a positive addition to classes. This study was performed on engineering students where the focus was on problem based learning whereas the fundamentals of anatomy requires a large volume of surface learning prior to application which may account for the differences in achievement recorded. This could also be an indication of the successful integration of the tablets to complement traditional teaching methods which is an area that requires further investigation.

A1 was used as an indication of baseline knowledge; A4 was a traditional viva voce examination where students were asked to apply the theory. The drop in grade between A1-A4 was significantly less in the tablet taught group compared to the traditionally taught groups suggesting that the Tablets were a positive in terms of knowledge retention and their ability to apply information or deeper learning. It has been suggested that students actively adapt their study approaches to suit the demands of a particular subject where anatomy requires some degree of both surface and deep processing to achieve (Willis, 1993). Developing classroom activities that draw information from multiple sources is thought to encourage students to adopt deep-processing methods that will improve retention. The tablet is a tool that allows this to occur via a common vehicle with multiple functions and apps alongside traditional classroom activities. Achievement was compared within-student between A1,A2,A3 and A4 assessment points where the tablet taught students showed a significant improvement at all points, the traditional, only between A1 and A4. This further compounds the suggestion that the tablets helped increase achievement and possibly allowed a faster transition from surface to deeper learning strategies or just as tools for engagement resulting in deeper learning.

In employing new technology in the form of tablets in class, there was always a risk that the learning itself would be eclipsed by the novelty of the delivery platform or that it could be the novelty value that has the positive or Hawthorne effect (Brand et al., 2011). However, this was not the case as the increases in grade were maintained across all assessment points indicating that the effect of the tablets was consistent throughout the year in both 2012-13 and 2013-14 cohorts. Although the tablet devices were not fully integrated into other modules of study as in Anatomy they were still utilised on a number of relevant occasions but the novelty value within the module could remain a feature. The novelty factor of the tablet has been discussed across all ages of learners (Sheppard, 2001; Mitchell, 2014) but there seems to be an agreement that the novelty factor should be utilised by the educator. The increased sensory input and novelty factor of the tablet to provide a fun, visual way of active learning can lead to increased engagement and if they are embedded into a course carefully this motivation should be maintained.

The second hypothesis was that tablets would improve student engagement. This could be construed to be in part measured by achievement but in this case attendance was used as a partial measure of engagement. Tablets have been found to help engagement and potentially enhance students' learning experience (Brand et al, 2011; Diemer, Fernandez & Streepey, 2012; Fontelo, Faustorilla, Gavino & Marcelo, 2012; Perez et al, 2011) which our study is in agreement with. If students are more engaged in their classes, attendance has been shown to improve, although it does not indicate outside class independent engagement (Junco et al., 2011). Attendance was significantly greater in the tablet classes suggesting that the results of our study agree with the bulk of the literature. Attendance can of course be affected by many things but students who enjoy and are active in their learning experience maintain higher contact levels (Deslauriers, 2011).

As in other studies utilising this form of technology, the introduction of tablets into seminar sessions seems to have been an overwhelmingly positive experience for the student group, with 97.2% of students in this study in agreement that their addition was positive (Bonds-Raacke and Raacke, 2008; Derting and Cox, 2008). The qualitative feedback suggests that mLearning using tablets is being utilised effectively to complement traditional practice.

'I really liked the variety in the seminars. That we use bones, blue-tack, make video, iPads and worksheets. It makes the learning more fun, and I find it easier to understand. I also enjoy that we work in groups' (Participant A).

'Anatomy seminars are the sessions i look forward to most. I learn kinaesthetically and visually so the use of the iPad fits my needs perfectly. I feel comfortable answering questions whether it's right or wrong as i know you'll push me towards fixing any wrong answers i may provide :)' (Participant B)

'I find that the seminars are far more useful in learning anatomy. Although the lectures were useful to bring people to the same level for the first few weeks, I am glad we no longer have them as the seminars offer more direct and hand on learning through the skeletons and iPads'(Participant C)

The feedback would suggest that the tablets added value to the learner experience and classroom environment without detracting from other pedagogical methods. iPads featured in 42 of the 96 responses in the online feedback and was the most occurring theme identified. Previous research has identified iPads as a possible distraction in class (Hargis et al, 2013; Link et al, 2012; Rossing et al, 2012), however, due to the structured manner in which they were integrated into the seminars this did not seem to be the case; if anything they were seen as a group cohesion tool. Link et al., (2012) identified the requirement for a clear role and time for the tablet to be used; the results from this study consolidate this as a necessity.

The only negative comment regarding tablets was that there should be more of them or given out individually by the university. This is an area that should be studied further, as to whether the tablet is similarly positive for the student as an independent tool or whether using a tablet or smartphone in class increases autonomous mLearning.. This was of course constrained by the budget of the project but it is thought that individual tablets could detract from the group learning environment and therefore limit peer feedback and sharing of ideas. This was the case in the study by Vu et al., (2014) where the most effective use was one per group as opposed to individual devices.

The study has a number of limitations inherent in this type of pedagogical research. The study has limited generalisability because it was only performed on two cohorts over two years in a single module at one University. It has, however, the advantage of having a control group, in part due to circumstance and timetabling. Furthermore, students' previous experiences of mobile learning and tablet use were not established and the qualitative feedback was voluntary and unstructured. The ethical considerations of pedagogical research need to be established at each stage within an action research project so as to not disadvantage the student learner and improve academic rigour in this field of research.

Conclusions

We can conclude from this study that integrating tablets and app-related learning material into Higher Education anatomy classes had a positive effect on student achievement and attendance. In a subject already utilising active learning through traditional methods the addition of technology via quizzes, 3D visual material and access to the internet could be an alternative method of engaging students in the learning process. Group learning environments can stimulate a positive learning environment through peer feedback, knowledge sharing and discussion, resulting in deeper learning; the tablet is a tool which can facilitate this. We need to develop a framework in agreement with Nyugen et al., (2014) setting out how tablets are best used in the classroom environment to maximise the effect on engagement and achievement. This will then enable researchers to take the next step and investigate whether facilitated use of mLearning devices in class transitions the students to increased independent use and autonomous engagement with mLearning outside of the classroom. Educators should look to use tablet devices and the applications it enables as part of an integrated seminar experience to enhance the learner experience and provide a vehicle for further use of mLearning via tablet or smartphone device. Educators may want to view seminar or taught experiences as a tool for students to 'learn to learn' how to effectively use mLearning as opposed to expecting independence away from the classroom without this facilitation.

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